

Fishery Data Series No. 96-33

Marking Juvenile Chinook Salmon in the Kenai River and Deep Creek, Alaska, 1995

by

Terry Bendock

November 1996

Alaska Department of Fish and Game

Division of Sport Fish



Symbols and Abbreviations

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Weights and measures (metric)		General		Mathematics, statistics, fisheries	
centimeter	cm	All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.	alternate hypothesis	H _A
deciliter	dL			base of natural logarithm	e
gram	g	All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.	catch per unit effort	CPUE
hectare	ha	and	&	coefficient of variation	CV
kilogram	kg	at	@	common test statistics	F, t, χ ² , etc.
kilometer	km	Compass directions:		confidence interval	C.I.
liter	L			correlation coefficient	R (multiple)
meter	m	east	E	correlation coefficient	r (simple)
metric ton	mt	north	N	covariance	cov
milliliter	ml	south	S	degree (angular or temperature)	°
millimeter	mm	west	W		
		Copyright	©		
Weights and measures (English)		Corporate suffixes:		degrees of freedom	df
cubic feet per second	ft ³ /s	Company	Co.	divided by	÷ or / (in equations)
foot	ft	Corporation	Corp.		
gallon	gal	Incorporated	Inc.	equals	=
inch	in	Limited	Ltd.	expected value	E
mile	mi	et alii (and other people)	et al.	fork length	FL
ounce	oz	et cetera (and so forth)	etc.	greater than	>
pound	lb	exempli gratia (for example)	e.g.,	greater than or equal to	≥
quart	qt	id est (that is)	i.e.,	harvest per unit effort	HPUE
yard	yd	latitude or longitude	lat. or long.	less than	<
Spell out acre and ton.		monetary symbols (U.S.)	\$, ¢	less than or equal to	≤
Time and temperature		months (tables and figures): first three letters	Jan,...,Dec	logarithm (natural)	ln
day	d			logarithm (specify base)	log
degrees Celsius	°C			mideye-to-fork	MEF
degrees Fahrenheit	°F			minute (angular)	'
hour (spell out for 24-hour clock)	h	number (before a number)	# (e.g., #10)	multiplied by	x
minute	min	pounds (after a number)	# (e.g., 10#)	not significant	NS
second	s	registered trademark	®	null hypothesis	H ₀
Spell out year, month, and week.		trademark	™	percent	%
Physics and chemistry		United States (adjective)	U.S.	probability	P
all atomic symbols				probability of a type I error (rejection of the null hypothesis when true)	α
alternating current	AC	United States of America (noun)	USA		
ampere	A			probability of a type II error (acceptance of the null hypothesis when false)	β
calorie	cal	U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)		
direct current	DC			second (angular)	"
hertz	Hz			standard deviation	SD
horsepower	hp			standard error	SE
hydrogen ion activity	pH			standard length	SL
parts per million	ppm			total length	TL
parts per thousand	ppt, ‰			variance	Var
volts	V				
watts	W				

FISHERY DATA SERIES NO. 96-33

**MARKING JUVENILE CHINOOK SALMON IN THE KENAI RIVER AND
DEEP CREEK, ALASKA, 1995**

by

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November 1996

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ABSTRACT

The Alaska Department of Fish and Game is assessing the contribution of selected wild stocks of chinook salmon *Oncorhynchus tshawytscha* to an expanding mixed-stock marine recreational harvest in Cook Inlet using a coded wire tag marking and recovery program. Chinook salmon stocks in the Kenai River, location of the largest freshwater sport fishery for chinook salmon in Alaska, and Deep Creek, a small stream near an expanding marine fishery for chinook salmon, were selected for assessment. An estimated 58,741 chinook salmon of Kenai River origin were marked and released during 1995. An estimated 13,568 chinook salmon and 9,671 coho salmon smolt of Deep Creek origin were marked and released during 1995. The number of chinook salmon marked in both rivers fell short of our anticipated goals. The harvest of these tagged cohorts of chinook salmon in marine fisheries will be estimated beginning in 1996. Chinook salmon smolt were present in lower Deep Creek throughout the summer with peak numbers emigrating between mid-June and mid-July. Two ages-classes of smolt were present in Deep Creek catches. We used a trapping efficiency method to estimate inseason abundance of smolt in Deep Creek during 1995, but estimates of efficiency were biased from the confounding effects of distance from the trap that marked smolt were released and time of day of release. A rotary screw trap was used successfully in the Kenai River delta to capture age-1 chinook salmon smolt.

Key words: chinook salmon, *Oncorhynchus tshawytscha*, smolt, fingerling, juvenile, coded wire tag, Kenai River, Deep Creek, Cook Inlet, mixed stock, recreational fishery.

INTRODUCTION

Chinook salmon *Oncorhynchus tshawytscha* stocks that return annually to Cook Inlet are considered fully utilized in existing fisheries. Escapement goals were established for managing major stocks of Cook Inlet chinook salmon. Attainment of these goals is assessed annually using aerial survey techniques, weirs, or sonar. Many gillnet and hook-and-line fisheries harvest mixed stocks of chinook salmon as they return to spawn in Cook Inlet drainages. Since the surplus of this resource is fully utilized, growth in one fishery may occur at the expense of another, complicating sustained yield management and causing economic disruption.

The Cook Inlet marine recreational fishery (Figure 1) harvests mixed stocks of chinook salmon along eastside Cook Inlet beaches from Ninilchik south to Anchor Point. Most effort in this fishery takes place within one-half mile from shore during May through July. Harvests are thought to be composed of mature fish returning primarily to Kenai Peninsula drainages and hatchery release sites. This fishery began in the early 1970s and remained fairly stable through the late

1980s. However, increased marketing by sport fish guiding and tourism industries, improved boat launching facilities, and restrictions in other Cook Inlet inriver fisheries resulted in recent growth in the marine fishery. Harvests of chinook salmon in the marine fishery increased by approximately 57% (2,700 fish) between 1987 and 1994 (Howe et al. 1995). This growth appears to be only modest at this time, yet stock specific contributions to the marine harvest remain unknown, and more conservative management has been necessary in several Cook Inlet drainages to meet escapement objectives. The lack of quantifiable harvest composition data precludes development of management objectives for the marine fishery and compromises our ability to reconstruct stock-specific adult returns of chinook salmon in other Cook Inlet drainages.

To address these concerns, the Alaska Department of Fish and Game (ADF&G) initiated a long-term study to assess growth and characteristics of the marine fishery, evaluate ongoing efforts to supplement harvests using hatchery fish, and estimate the harvest of specific wild stocks by the marine

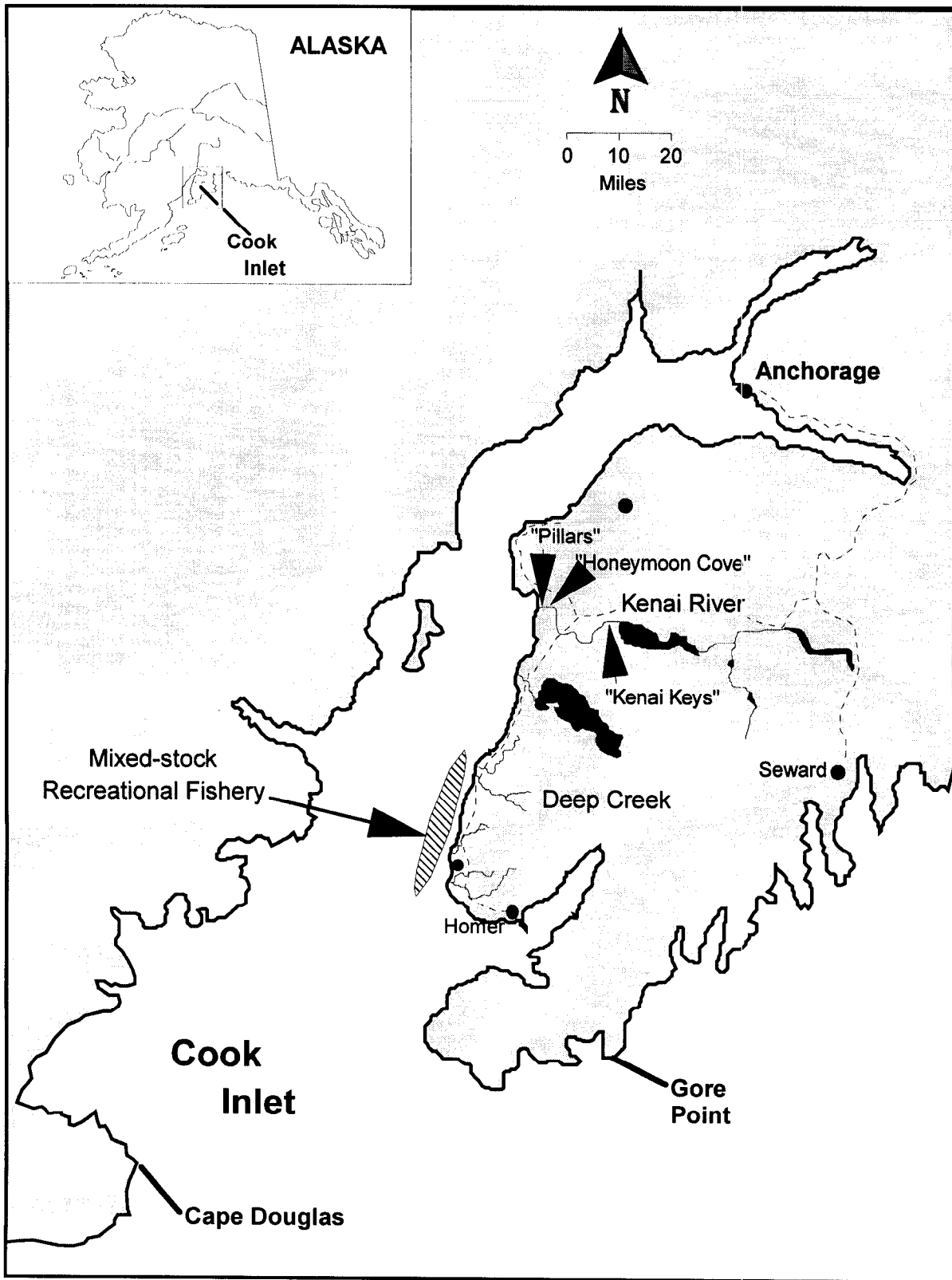


Figure 1.-Map of Cook Inlet showing the locations of the Kenai River, Deep Creek, and the marine recreational fishery.

fishery. As part of this long-term effort, the harvest of wild Kenai River and Deep Creek chinook salmon, as well as the harvest of hatchery chinook salmon released in Cook Inlet, will be estimated using a coded wire tag (CWT) marking and recovery program. Marking wild chinook salmon of known origin is an essential step in this process and is the subject of this report.

Kenai River and Deep Creek were selected as candidate streams for tagging wild salmon for different reasons. The Kenai River supports the largest freshwater chinook salmon fishery in Alaska (Howe et al. 1995). Exploitation of early- and late-run chinook salmon bound for the Kenai River is governed by management plans adopted by the Alaska Board of Fisheries. These plans stipulate specific escapement goals for each run and how these fisheries are to be managed in the event of a conservation shortfall. The Kenai River is also the primary Cook Inlet drainage having late-run chinook salmon. Hence, all chinook salmon harvested in Cook Inlet after July 1 are assumed to originate in the Kenai River. All other chinook salmon stocks entering Cook Inlet exhibit early-run timing and are harvested in unknown proportions in the marine fisheries. Estimating the harvest of early-run Kenai River chinook salmon by the marine fishery will provide a final piece of harvest data necessary for total run reconstruction, and will provide important information for making allocative decisions concerning the harvest of this stock.

Deep Creek was selected as a tagging site because of its proximity to the expanding marine fishery. Deep Creek supports a small run of chinook salmon that is harvested on weekends only from Memorial Day through the third week of June. The marine fishery takes place in Cook Inlet south of a one-mile radius from the mouth of Deep Creek. Additional exploitation of Deep Creek fish in

marine waters may result in the overharvest of this conservatively managed stock. Estimating the harvest of Deep Creek chinook salmon by the marine fishery will therefore provide important information for making conservation and allocative decisions concerning the harvest of this stock. Coho salmon *O. kisutch* smolt were also tagged in Deep Creek during 1995 to provide additional information on the mixed-stock harvest of this species in Cook Inlet.

This report documents the methods and numbers of wild juvenile chinook and coho salmon that were marked and released in Deep Creek, and chinook salmon that were marked and released in the Kenai River during 1995. Additional information on estimates of smolt abundance in Deep Creek and the feasibility of using a rotary screw trap in the Kenai River to capture chinook salmon is presented. We will begin estimating the harvest of these tagged cohorts by the marine fishery in 1996.

METHODS

STUDY DESIGN

To achieve our goal of estimating the harvest of Kenai River and Deep Creek chinook salmon by the Cook Inlet marine recreational fishery, a sample of juvenile chinook salmon from each drainage was captured, marked with coded wire tags and an adipose finclip, and released. Marking juvenile salmon in freshwater rearing habitats permits a positive identification of the natal drainage (stock) in which the fish were produced. The stocks composing mixed-stock fisheries can be identified by examining marked adult salmon in the harvest. Knowledge of the total harvest, proportions of marked and unmarked fish in each stock, and the numbers of marked fish in the harvest are critical elements for estimating stock-specific harvests in the marine fishery.

To estimate the harvest of a stock by a mixed-stock fishery, an estimate of its marked proportion is required. Since this proportion is unknown at the completion of marking, it will be estimated for each stock by examining a sample of the inriver return of adults. An examination of adults will establish whether or not the marked proportion of the return remains constant or varies over time. A constant proportion of marked adults will indicate that a representative sample of juveniles was marked. This proportion will then represent the marked proportion available to the mixed-stock fishery and will be used to estimate the harvest of the stock of known origin.

A variable proportion of marked adults in the inriver return will indicate bias in the marked sample of released juveniles. Variation in the inriver marked proportion is indicative of temporal changes in the marked proportion passing through the mixed-stock harvest area. At present, it is not possible to accurately apply changing marked proportions to the marine fishery because the lag times of adult chinook salmon migrating through the fishery are unknown.

ESTIMATING SAMPLE SIZE REQUIREMENTS

We used procedures outlined in Meyer et al. (*Unpublished*) to estimate the number of juvenile chinook salmon to mark in the Kenai River and Deep Creek. The first step in determining sample size requirements was to estimate average smolt/fingerling abundance. We accomplished this by dividing the average estimated total return by an approximate smolt-to-adult survival rate. The resulting quotient was then divided by an approximate fingerling-to-smolt survival rate to estimate the number of fingerlings in the population. The average total return of chinook salmon to the Kenai River from 1986-1994 was nearly 61,100 (Hammarstrom 1995a, 1995b).

Hence, the number of Kenai River fingerling chinook salmon was estimated by:

$$\frac{61,100 \text{ (Total Return)}}{0.05 \text{ (Smolt Survival)}} = 1,222,000 \text{ (Smolts)} \quad (1)$$

$$\frac{1,222,000 \text{ (Smolts)}}{0.5 \text{ (Fingerling Survival)}} = 2,444,000 \text{ (Fingerlings)} \quad (2)$$

Similarly, the estimated average total return to Deep Creek from 1988-1991, calculated by summing inriver harvest estimates (Mills 1989-1992) and aerial escapement survey estimates (Nelson *Unpublished*), was 2,100. The number of Deep Creek chinook salmon smolt to mark was estimated by:

$$\frac{2,100 \text{ (Total Return)}}{0.05 \text{ (Smolt Survival)}} = 42,000 \text{ (Smolts)}. \quad (3)$$

Next, we estimated the number of fingerling or smolt (t) to be marked (Clark and Bernard 1987):

$$t = \frac{\left(\frac{z^2 N_s}{\phi} \right)}{nd^2 + z^2}, \quad (4)$$

where:

- z = the acceptable probability of a type I error,
- N_s = smolt or fingerling abundance at the time of tagging,
- ϕ = the fraction of the marine harvest examined for tags,
- n = an a priori estimate of harvest, and
- d = the desired relative precision of the estimate.

Assuming $z = 1.645$ ($\alpha = 0.10$), $N_s = 2,444,000$, $\phi = 0.5$, $n = 1,500$, and $d = 0.20$, then the number of Kenai River fingerling to be tagged is 210,600. Whereas, assuming $z = 1.645$ ($\alpha = 0.10$), $N_s = 42,000$, $\phi = 0.5$, $n = 100$, and $d = 0.20$, then the number of Deep

Creek chinook salmon smolt to be tagged is 33,900.

CODED WIRE TAG DEPLOYMENT

Methods of capturing fish in the Kenai River and Deep Creek were dissimilar due to the physical characteristics of both rivers and different ages of fish used for marking in each system.

Kenai River

Two procedures were used to capture chinook salmon in the Kenai River. Baited minnow traps were used to capture fingerling (age-0) chinook salmon; a rotary screw trap was used to capture age-1 smolt. Baited minnow traps were demonstrated in previous studies to be an effective gear for catching fingerlings (Burger et al. 1983, Bendock 1989). Minnow traps measuring 48 cm X 20 cm X 0.6 cm and baited with brine-cured salmon roe were used to capture fingerling chinook salmon in the Kenai River during 1995. Traps were deployed near the mainstem shoreline from river mile (rm) 13 to rm 16 during 25 July through 30 August 1995.

Twelve baited minnow traps were typically deployed along 200 ft of shoreline for approximately 20 min each. The resulting catch was placed into 5-gallon plastic buckets and transported by boat to a centrally located (rm 15) tagging facility. Fish were then transferred to screened holding pens that were secured in the water column. Chinook salmon fingerlings ≥ 55 mm FL were anesthetized with tricaine methanesulfonate (MS-222), marked by removing the adipose fin, and injected with a full (1.0 mm) or half length (0.5 mm) coded wire tag using a Northwest Marine Technologies Inc. (NMT) Mark IV tag injector. A 55 mm FL threshold size was selected following discussions with NMT about the use of full length tags. Tagged fish were passed head-first through an NMT

quality control device that magnetized and confirmed the presence of each tag. Fish were then allowed to recover in a holding pen for approximately 1 hour and released at their point of capture. Short-term handling mortality and tag retention rates were estimated using observed frequencies of a daily random sample of approximately 200 tagged fish that was held overnight (18 to 24 h), inspected for dead fish, and passed again through the quality control device to detect the presence of tags. We trapped fish along both shorelines beginning at the downstream end of each tagging reach and systematically advanced upstream after marked fish were returned to a site. Species other than chinook salmon were released.

Chinook salmon emigrate from the Kenai River as age-1 smolt. Tagging age-1 smolt instead of fingerlings in the Kenai River would eliminate losses of marked fish due to overwintering mortality and predation. However, efforts to capture large numbers of age-1 chinook salmon smolt have not been successful in the Kenai River using minnow traps, fyke nets, or beach seines (Burger et al. 1983; Bendock 1989). In 1995, we examined the feasibility of capturing chinook salmon smolt using a rotary screw trap. A single, 8 ft diameter rotary screw trap constructed by E. G. Solutions of Corvallis, Oregon was fished from 1 to 37 d during the outmigration of chinook salmon smolt at seven locations in the Kenai River (Figure 2); four in the Kenai River delta (Figure 3) and three in the mainstem Kenai River. The catch was removed from the trap once daily. At each location, daily catch by species was recorded and chinook salmon were measured (FL). Air and water temperature, and salinity were recorded daily after 27 August. A limited number of tags was also deployed during this effort following procedures outlined above.

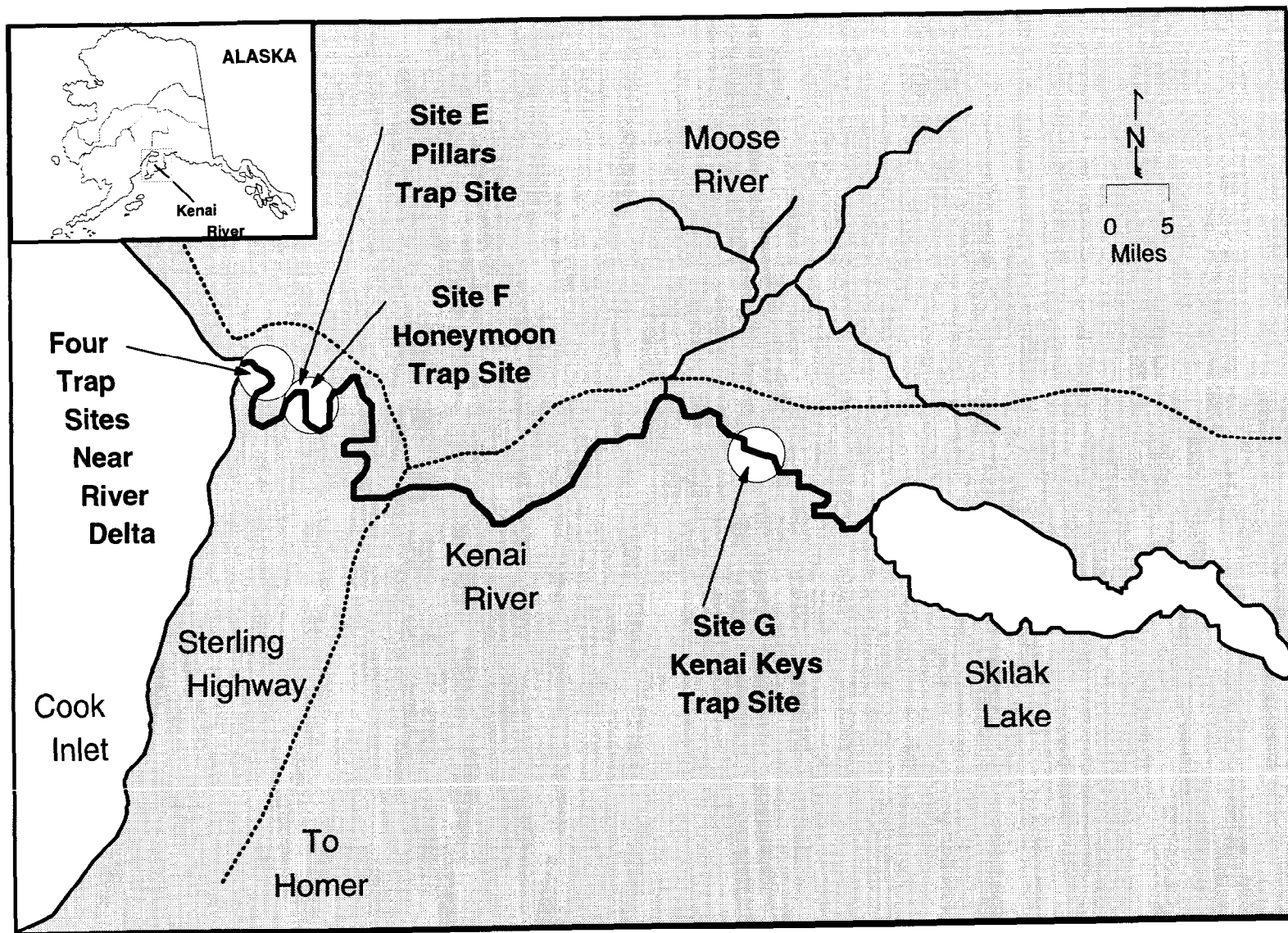


Figure 2.-Locations of smolt trap used in the Kenai River, 1995.

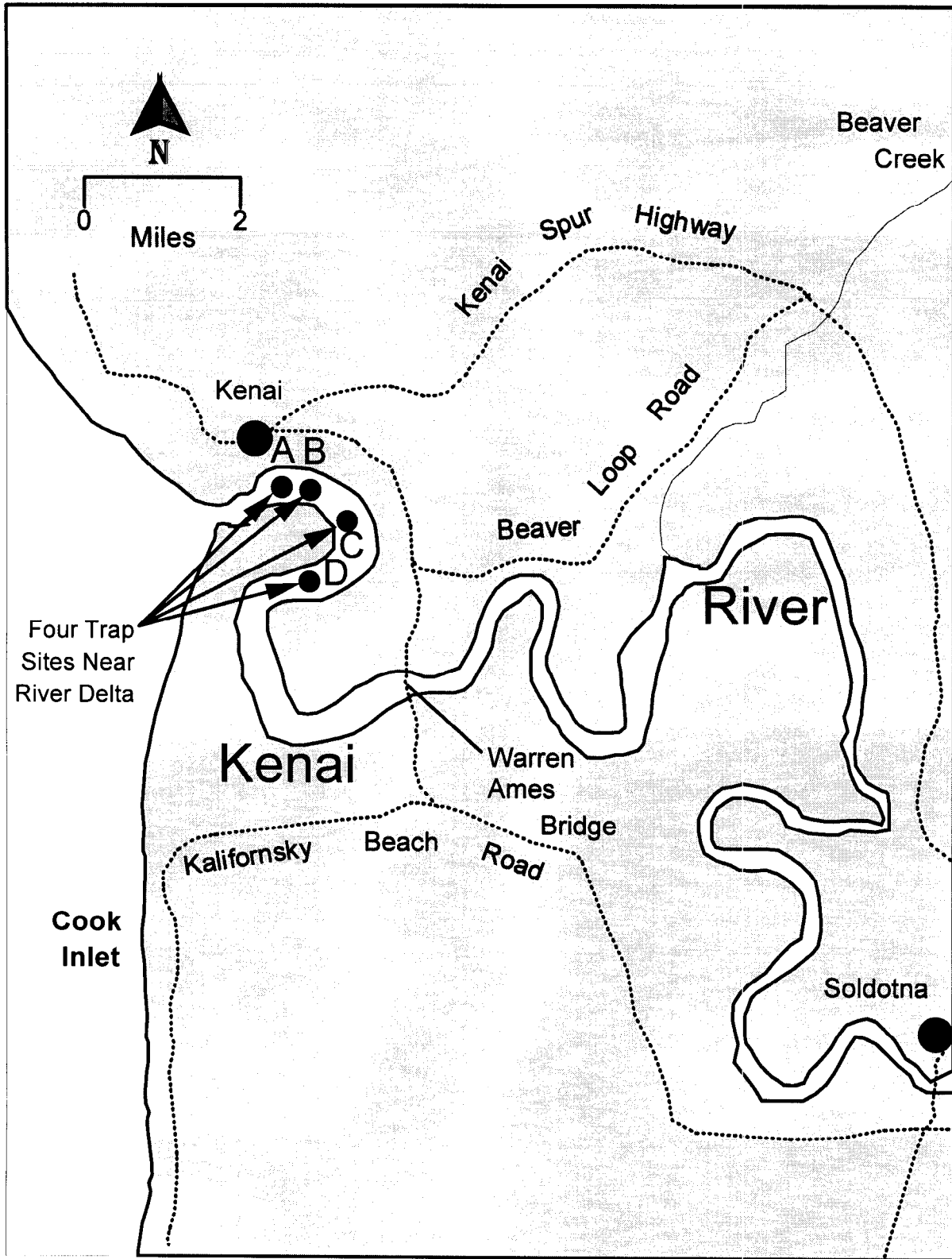


Figure 3.-Delta trap sites, 1995.

Deep Creek

A rotary screw trap was operated in Deep Creek approximately one-half mile above its confluence with Cook Inlet. The trap had an 8 ft diameter upstream opening and was positioned in the thalweg adjacent to a steep riprap bank where emigrating smolt were presumed present. The trap was fished continuously from 16 May through 12 August 1995. Technicians left the trap unattended at night but inspected it every 2-3 hours between 0800 hours and 2300 hours. Fine debris which collected on the trap cone was removed using a high pressure water hose. Captured fish were removed from the live box each morning. Chinook and coho salmon smolt were placed in separate holding pens, while other species were identified, counted, and released. Catch composition, water and air temperature, water level (using a staff gauge), and trap revolutions per minute were recorded daily. Salmon smolt were tagged using procedures identical to those described above for the Kenai River. All tagged smolt were released into Deep Creek approximately 100 ft downstream from the trap.

Chinook salmon in Deep Creek appear to emigrate as both age-0 and age-1 smolt and the two age classes were simultaneously represented in Deep Creek catches. Age-0 (1994 brood year) and age-1 (1993 brood year) fish were distinguished by their different sizes (Bendock 1995). All smolt ≥ 55 mm FL were tagged. Separate tag codes were used for age-0 and age-1 chinook salmon smolt and for coho salmon smolt.

Estimating Abundance of Emigrating Smolt

A series of mark-recapture experiments were conducted to estimate the abundance of chinook salmon, coho salmon, and Dolly Varden *Salvelinus malma* smolt emigrating from Deep Creek. Although estimating smolt

abundance was not an objective of this study, we were able to obtain data to make these estimates at no additional cost to the project. Estimates of smolt abundance may help us establish better marking goals, improve our methods for capturing smolt, contribute to our knowledge of the freshwater and marine variabilities of salmonid production, provide indexes of smolt abundance, evaluate escapement goals, and forecast future returns.

A sample of captured smolt of each species was anesthetized, marked, and released upstream of the rotary screw trap. Efficiency of the trap to capture smolt of each species was estimated by tallying the number of marked smolt recaptured during each experiment. An estimate of abundance was obtained by relating trap efficiency to the total number of unmarked smolt captured during the experiment (Seber 1982, Rawson 1984).

The 3-month trapping season was divided into thirteen, 7-day temporal strata with one mark-recapture experiment conducted for each species during each stratum. To examine differences in efficiency relative to distance released upstream from the trap, two release sites were used. A minimum of 200 smolt of each species was marked during each experiment. Half of each sample (i.e., 100 smolt per species per experiment) was marked with an upper caudal finclip and released approximately 1.5 km upstream of the trap. The remaining half of each sample was marked with a lower caudal fin clip and released approximately 300 ft upstream of the trap.

During May and June events, smolt were released at the lower site at approximately 1500 hours and at the upper site at approximately 1700 hours. However, in July and August we continued to release fish at the upper site at 1700 hours, but delayed releasing

fish at the lower site until approximately 2300 hours.

The feasibility of estimating smolt abundance using this approach in Deep Creek was explored in 1994 (Bendock 1995). Assumptions of the closed population model are (Seber 1982, Rawson 1984):

1. Each individual has an equal probability of capture during the first event OR the second sample is a simple random sample OR marked individuals mix completely with unmarked individuals between events. A corollary is that each individual is captured independently of the capture fate of all other individuals.
2. Capture, handling, and marking do not affect subsequent probability of capture of any individual.
3. Marked individuals released upstream of the trap pass the trap during the experiment.
4. Trap efficiency for a species is constant during the time interval of the experiment.
5. Unmarked individuals are not in double jeopardy of being captured (i.e., unmarked individuals pass the trap and may be captured only once).
6. Marks are not lost between events.
7. Each individual captured is counted, species is correctly identified, all marked individuals recaptured are identified, and all data are correctly recorded.

Fork length was measured on all marked and all recaptured individuals. A Kolmogorov-Smirnov (KS) test was used to compare the length distributions of all individuals marked and released to all marked individuals recaptured during each experiment. Significant differences in the length distribution of these two groups indicate potential size selectivity of the trap.

Chi-square tests were conducted to examine differences in mark-recapture data by release site and among temporal strata.

If different release locations result in different efficiencies, it may be difficult or impossible to estimate the true trap efficiency and, therefore, the outmigration of smolt. Differences among weeks will require stratifying. Weeks that are not different can be pooled to improve precision. Differences in length distributions of captured/marked and recaptured fish suggest size selectivity of the rotary screw trap, which would require post-stratifying data by length to minimize bias.

RESULTS

KENAI RIVER ROTARY SCREW TRAP CATCHES

We operated the rotary screw trap for 9 days in the mainstem Kenai River during the second half of June and for 52 days in the Kenai River Delta during 28 June to 21 September (Appendix A2). Smolt catches at the three upriver sites were composed of coho salmon (84%), chinook salmon (12%), and sockeye salmon (4%). Low catch rates for chinook salmon (4 to 36 fish per night, mean = 13) precluded further feasibility work with the screw trap in the upper river.

Subsequent sampling with the rotary screw trap was conducted at four locations in the Kenai River delta (Figure 3). At each location the trap was secured to a mooring buoy that was anchored to the streambed using a 1,000 lb Danforth-style anchor. A total of 4,328 chinook salmon smolt was captured in the Kenai River delta. Overnight catches of chinook salmon ranged from 0 to 366 smolt and averaged 83 smolt. Total catches in the delta were highest for sockeye salmon (53%), followed by chinook salmon (45%), and coho salmon (2%). Although sampling in the delta was not continuous, coho salmon smolt were

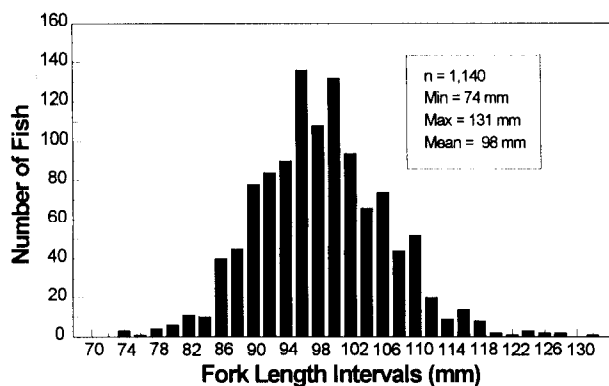


Figure 4.-Length frequency distribution for age-1 chinook salmon smolt captured in the Kenai River delta, 1995.

captured infrequently, sockeye salmon catches were highest in late June through early July, and chinook salmon smolt catches were highest in early August (Appendix A2).

Chinook salmon smolt captured in the Kenai River delta ($n = 1,140$) ranged from 74 mm to 131 mm FL and averaged 98 mm (Figure 4).

DEEP CREEK CATCH COMPOSITION AND SMOLT TIMING

A rotary screw trap was installed in Deep Creek on 16 May and fished continuously for 89 d until 12 August 1995. The trap sampled approximately 9% of the available water column (Figure 5). Stream discharge decreased and water temperature increased throughout the sampling period at Deep Creek (Figure 6). Water depth ranged from a high on 24 May to a low in mid-July. Water

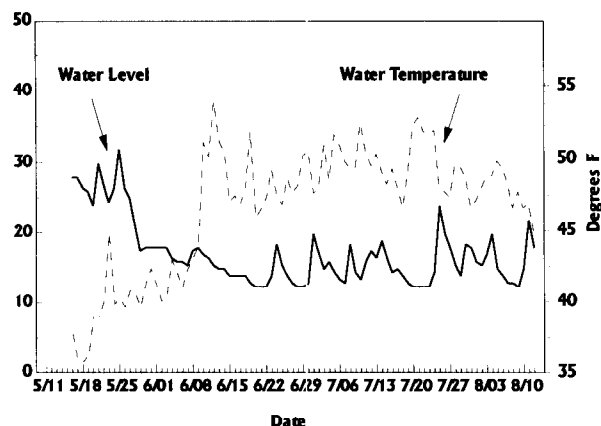


Figure 6.-Daily water level and temperature in Deep Creek, 1995.

level declined steadily through mid-June, and then remained low for the rest of the season except during brief freshets. Water temperature ranged from 38°F to 56°F. Water temperature increased rapidly by mid-June and then remained relatively high through early August.

Eleven species of freshwater and anadromous fish were captured in Deep Creek using the rotary screw trap. Daily catches were tallied for smolt, which included four emigrant species: Dolly Varden, coho salmon, steelhead *O. mykiss*, and chinook salmon (Appendix A1). A total of 33,233 smolt was captured in Deep Creek from 16 May through 12 August 1995. Chinook salmon accounted for the majority of the catch (53%), followed by coho salmon (33%), Dolly Varden (12%),

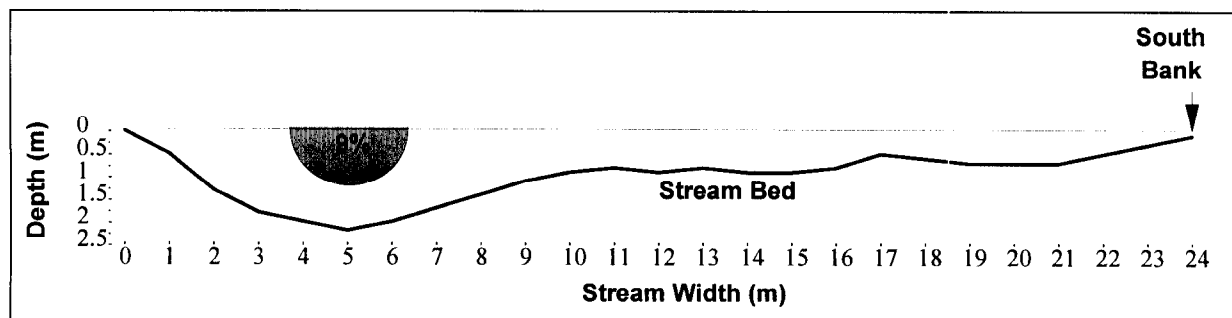


Figure 5.-Schematic cross section of Deep Creek showing the sampling area of the rotary screw trap.

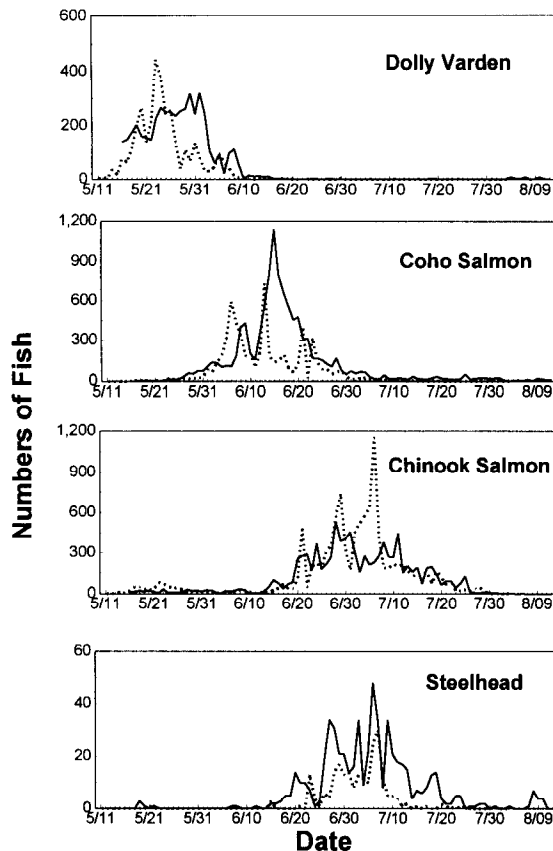


Figure 7.-Emigration timing for salmonid smolt captured in Deep Creek during 1994 (dotted lines) and 1995 (solid lines).

and steelhead (2%). Two age classes of juvenile chinook salmon were captured in Deep Creek concurrently. Age-1 and age-0 chinook salmon smolt were easily distinguished by their different lengths (Bendock 1995).

Emigration timing for each of these species was unique, resulting in the presence of smolt in Deep Creek throughout most of the open water season (Figure 7). A total of 4,075 Dolly Varden was captured in Deep Creek. Dolly Varden smolt emigrated first during mid-May through early June with a peak catch on 1 June. Dolly Varden smolt ranged from 105 mm to 206 mm FL and averaged 134 mm (Figure 8).

A total of 10,822 coho salmon was captured in Deep Creek. Coho salmon smolt emigrated throughout June with a peak catch on 15 June (Figure 7). Coho salmon smolt ranged from 71 mm to 152 mm and averaged 106 mm (Figure 8).

A minimum of 17,757 chinook salmon smolt was captured in Deep Creek. Chinook salmon smolt were present throughout the entire sampling period; however, most chinook salmon emigrated during mid-June through mid-July (Figure 7). We did not attempt to enumerate chinook salmon that were less than 55 mm FL. The peak catch of age-1 chinook salmon smolt occurred on 28 June, while age-0 smolt catch peaked on 24 July. Age-0 chinook salmon ranged up to 96 mm FL and averaged 69 mm. Age-1 chinook salmon ranged from 68 mm to 103 mm FL and averaged 87 mm (Figure 8).

Steelhead catches peaked on 7 July but our small total catch of steelhead ($n = 579$) precluded detailed analysis.

Trap catches of all species were significantly related to time of day. During 23 May through 22 June, 97% of the chinook salmon, 99% of the coho salmon, and 98% of the Dolly Varden smolt were caught at night, between 2300 hours and 0700 hours. We did not analyze data collected after 22 June because of the consistent results between 23 May and 22 June.

CHINOOK SALMON TAGGING

Tagging results are presented separately for chinook salmon released in the Kenai River and Deep Creek. Tagging results for coho salmon are included in the section on Deep Creek.

Kenai River

An estimated 58,741 chinook salmon ≥ 55 mm FL were marked using coded wire tags

and released in the Kenai River from 22 June through 31 August 1995 (Table 1; Appendix B1). The total includes 57,262 age-0 fingerlings that were captured in baited minnow traps and released at rm 13-16 from 25 July through 31 August. The remaining 1,479 tags were deployed on age-1 smolt that were captured using a rotary screw trap at rm 2 from 22 June through 18 July. The number of fingerlings tagged daily ranged from 775 to 3,047 and averaged 2,171 fish. Daily rates for smolt tagging ranged from 26 to 257 and averaged 134 fish. Overall short-term mortality rates associated with fish handling and tagging were 1.1% and 0.2% for fingerling and smolt, respectively. Overnight tag retention rates were 97.9% for fingerling and 100% for smolt.

Deep Creek

An estimated 13,568 chinook salmon smolt were marked and released in Deep Creek during 1995 (Appendix B1). Of this total, 8,394 were age-1 emigrants from the 1993 brood year, while the remaining 5,174 were age-0 emigrants from the 1994 brood year (Table 2). Short-term tag retention and mortality rates for age-0 smolt were 97.4% and 0.4%, respectively, and for age-1 smolt were 97.1% and 0.3%. Average daily tagging rates for age-0 and age-1 smolt were 205 and 114 fish, respectively.

An estimated 9,671 coho salmon smolt were also marked and released in Deep Creek during 1995. Short-term tag retention and mortality rates for coho salmon smolt were 99.9% and 0.1%, respectively. The average daily tagging rate for coho salmon smolt was 179 fish.

DEEP CREEK SMOLT ABUNDANCE

The Dolly Varden emigration was underway by the time we installed the screw trap in Deep Creek. We conducted four mark-recapture experiments using Dolly Varden

smolt but were unable to capture a minimum of 200 smolt to mark and release during half of these events, and did not recapture sufficient numbers of smolt (≥ 10 ; Seber 1982; Rawson 1984) in any event to generate an estimate of abundance.

Coho Salmon

A total of 651 coho salmon smolt was marked and released in Deep Creek to estimate trapping efficiency for this species. Marked smolt were released on three occasions with half (326) of the fish released at the upper site, and the remainder released at the lower site. Two-hundred one marked smolt were recovered for an overall efficiency of 31% (Table 3). During each event, smolt were released at 1700 hours at the upper site and 1500 hours at the lower site. There were no

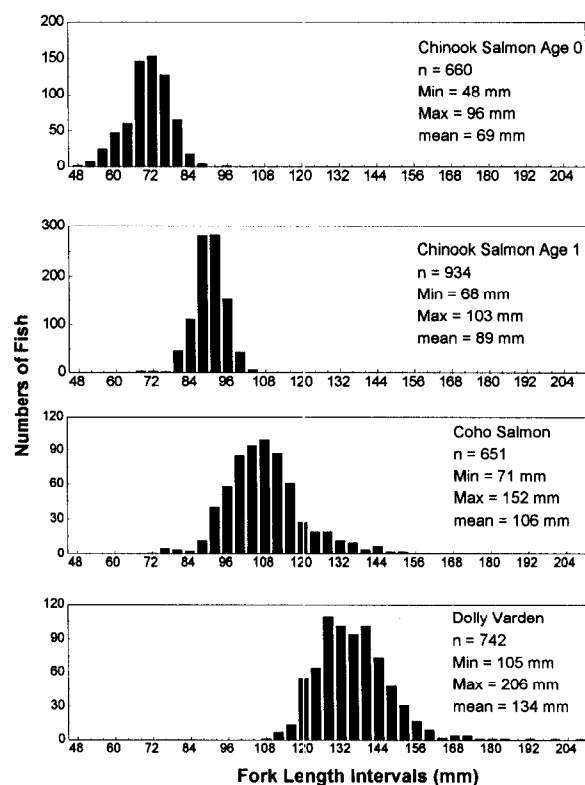


Figure 8.-Length frequency distributions for salmonid smolt captured in Deep Creek, 1995.

Table 1.-Dates, codes, and numbers of chinook salmon marked with coded wire tags and released in the Kenai River during 1995.

Year	Species	Location	RM	Dates	Codes	Brood		
						Year	Age	Number ^a
1995	Chinook	Kenai River	2	6/22-7/19	13-01-03-08-03	1993	1	1,479
1995	Chinook	Kenai River	15	7/25-8/03	13-01-03-08-04	1994	0	14,030
1995	Chinook	Kenai River	15	8/03-8/14	13-01-03-08-05	1994	0	13,724
1995	Chinook	Kenai River	15	8/14-8/22	13-01-03-08-06	1994	0	13,745
1995	Chinook	Kenai River	15	8/22-8/30	13-01-03-08-07	1994	0	13,752
1995	Chinook	Kenai River	15	8/30-8/31	13-01-03-08-08	1994	0	2,011
Total								58,741

^a Estimated number of tags deployed.

Table 2.-Dates, codes, and numbers of chinook and coho salmon marked with coded wire tags and released in Deep Creek during 1995.

Year	Species	Location	RM	Dates	Codes	Brood		
						Year	Age	Number ^a
1995	Chinook	Deep Creek	0.5	5/17-6/25	31-24-02	1993	1	2,183
1995	Chinook	Deep Creek	0.5	6/25-7/21	31-22-35	1993	1	5,719
1995	Chinook	Deep Creek	0.5	7/21-8/02	13-01-03-08-15	1993	1	492
1995	Chinook	Deep Creek	0.5	7/14-8/12	13-01-03-08-09	1994	0	5,174
Total								13,568
1995	Coho	Deep Creek	0.5	5/18-6/17	31-22-33	1992	2	5,760
1995	Coho	Deep Creek	0.5	6/17-7/20	31-22-34	1992	2	3,911
Total								9,671

^a Estimated number of tags deployed.

Table 3.-Summary statistics for mark-recapture events in Deep Creek, 1995.

Event	Date	Release		Sample Sizes			P-value ^a
		Site	Time	Recovered	Not Recovered	Total	KS Test
<u>Chinook Salmon</u>							
1	6/21	Upper	1700	36	84	120	0.85
		Lower	1500	11	109	120	0.72
2	6/28	Upper	1700	10	110	120	0.96
		Lower	1500	2	118	120	0.85
3	7/05	Upper	1700	16	91	107	0.92
		Lower	2300	16	91	107	0.41
4	7/14	Upper	1700	31	89	120	0.96
		Lower	2330	41	79	120	0.88
5	7/19	Upper	1700	40	80	120	0.18
		Lower	2300	30	90	120	0.94
6	7/26	Upper	1700	29	71	100	1.00
		Lower	2300	21	79	100	0.31
7	8/02	Upper	1950	42	58	100	0.18
		Lower	2230	54	66	120	0.68
<u>Coho Salmon</u>							
1	6/07	Upper	1700	49	37	86	1.00
		Lower	1500	20	64	84	0.33
2	6/14	Upper	1700	48	72	120	0.09
		Lower	1500	39	82	121	0.08
3	6/21	Upper	1700	34	86	120	0.46
		Lower	1500	11	109	120	0.11

^a P-value of the test comparing length distribution of all fish marked and released to that of recovered, marked fish. The Kolmogorov-Smirnov (KS) test compares the entire cumulative length distribution of the two groups.

significant differences in length distributions between smolt that were marked and released and those recaptured during any of the experiments.

Trap efficiency for coho salmon differed widely between release sites and among events. Trap efficiency ranged from 28% to 57% for smolt released at the upper site and from 9% to 32% at the lower site. Significant differences in trap efficiencies due to the distance from the trap that marked smolt were released were observed in two of the three sampling events. In each case, more marked coho salmon were recovered from our upper release site than from the lower site. Hence, an unbiased estimate of trapping efficiency for coho salmon was not attainable during 1995 due to differences resulting from release locations.

Chinook Salmon

A total of 1,594 chinook salmon smolt was marked and released at two sites during seven weekly mark-recapture experiments from 21 June to 2 August (Table 3). Three hundred seventy-nine smolt were recaptured for an overall trap efficiency of 24%. There were no significant differences ($P \geq 0.18$) in lengths of chinook salmon between those that were marked and released, and those that were recaptured. Trap efficiency for chinook salmon appeared to differ between release locations, but these results were confounded by time of day of release. Significantly fewer chinook salmon were recovered from the lower site than from the upper site for fish released during 21 June ($\chi^2 = 16.5$, $df = 1$, $P < 0.001$) and 28 June ($\chi^2 = 5.6$, $df = 1$, $P = 0.02$). On these dates fish were released at nearly the same time of day: at 1500 hours at the lower site and at 1700 hours at the upper site. However, beginning on 5 July we delayed releasing fish at the lower site from 1500 hours until 2300 hours and all subsequent experiments showed no significant

differences (range $\chi^2 = 0.00 - 2.02$, $df = 1$, range P -value = 0.16 - 1.00) in trap efficiency by release location.

As in the case of coho salmon smolt, an unbiased estimate of trap efficiency for chinook salmon smolt was not attainable during 1995 due to the confounding effects of distance from the trap that marked smolt were released and the time of day of release.

DISCUSSION

CHINOOK SALMON TAGGING

Numerous factors affect the number of fish to mark to estimate harvest of a cohort in mixed-stock fisheries. These include the number of fish available, desired levels of relative precision and accuracy of the estimate, the fraction of the harvest inspected for marks, an a priori estimate of contribution, catchability, and costs. We did not achieve our marking goals in either the Kenai River or Deep Creek during 1995. We marked 28% of our goal for the Kenai River in 1995 compared to 42% and 72% in 1994 and 1993, respectively. In Deep Creek we tagged 40% of our goal in 1995 compared to 39% in 1994. It is not possible, at this time, to verify the assumptions that were used to generate the marking goals since we can not estimate smolt abundance until marked adults return. If subsequent adult returns verify our estimates of smolt abundance, we will need to increase our tagging rates or increase the fraction of the harvest inspected to meet our desired levels of precision and accuracy. Developing methods to estimate the inseason abundance of smolt and fingerlings would also aid in establishing marking goals and strategies.

KENAI RIVER SMOLT TAGGING

Increasing the number of juvenile chinook salmon marked in the Kenai River can be best accomplished by tagging age-1 smolts instead of age-0 fingerlings. By tagging smolts, we

will avoid overwinter losses of marked fingerlings and thereby reduce the overall marking goal for the Kenai River.

Trapping results during 1995 demonstrated that rotary screw traps, anchored to mooring buoys in the Kenai River delta, are effective for capturing both sockeye and chinook salmon smolt. Debris loading on the trap cone was not a problem during 1995 and other trap maintenance problems were minimal. Tidal conditions influenced trapping efficiency. Rotary trap cones must rotate (using river current) to capture fish; however, once fish enter the live-box they cannot escape, even if the cone stops rotating. Tidal action in the river delta rendered our trap inactive for part of each day (slack tides). When tidal exchanges are low, the trap may only rotate for a few hours during each ebb tide, but on days having higher tidal exchanges, the trap rotates on both the flood and ebb tides.

Salinity may vary from 0 to 23 ppt during a 12 h period in the Kenai River delta. Fish held in our live box were often subjected to rapid and extreme changes in salinity. Mortality associated with trapping in the delta was limited to eulachon *Thaleichthys pacificus* and small numbers of Pacific sandfish *Trichodon trichodon*. While we did not observe any mortality of salmon smolt in the live box, decreasing the interval of time between trap checks may reduce incidental mortalities.

We recommend operating two 8 ft diameter screw traps secured to a single mooring buoy in the Kenai River delta during 15 May through 30 August 1996. Since smolt emigrating during 1996 are the progeny of the 1994 brood year, tags deployed on smolt will be in addition to those deployed on fingerling chinook salmon during 1995 and will increase the overall number of marked fish for that brood year.

SMOLT TIMING, AGE, AND SIZE

Our results from Deep Creek suggest that chinook salmon smolt emigrate from this system throughout much of the open water season with peak movements in early summer during mid-June through mid-July. Smolt timing coincided with peak water temperatures and seasonal low flows but movements appeared stimulated by freshets. While coho salmon and Dolly Varden were usually absent in catches prior to and following their respective emigration from Deep Creek, chinook salmon smolt were present throughout the entire trapping period. Similar chinook salmon peak emigration times are reported for other Cook Inlet drainages including the Anchor River (Allin 1957), Kasilof River (Waite 1979) and the Kenai River (King et al. 1993). Emigration times for Cook Inlet chinook salmon stocks are later than those reported for stocks in more southern latitudes (Healey 1991).

Juvenile chinook salmon in Alaska typically rear in fresh water for at least 1 year before migrating to sea as "stream-type" smolts. Large downstream movements of fry immediately following emergence are typical of most chinook populations, but "ocean-type" smolts, which emigrate from the river at age-0 and rear in the estuary until smoltification, are only reported from the Situk River in Alaska (Johnson et al. 1992). Stream and ocean-type chinook salmon, occupying the same tributary, are only reported in large systems such as the Columbia River and often are spatially or temporally isolated; associated with distinct seasonal adult spawning times or areas and ocean migration patterns (Taylor 1990). Return timing and other characteristics of adults in Deep Creek reflect the presence of a single chinook salmon race. Hence, the existence of both races of juveniles in Deep

Creek is inconsistent with the current hypothesis that different early life-history types reflect different adult behaviors and are, at least in part, genetically controlled (Taylor 1990, Healey 1991). Our evidence suggests that age-1 smolt emigrate from Deep Creek during June and July, and age-0 smolts emigrate beginning in late July, upon reaching approximately 70 mm FL. More work is required to confirm the presence of age-0 smolt in Deep Creek. Since this age class was marked with unique tag codes during 1994 and 1995, we can ascertain the importance of this strategy as adults return in subsequent years. To date, age-0 chinook salmon smolt have not been observed in the Kenai River drainage.

SMOLT ABUNDANCE ESTIMATES

Inseason estimates of smolt abundance are often desired as a cost-effective approach for stock assessment tagging strategies and to aid in forecasting adult returns. In Deep Creek, we could not generate an unbiased estimate of trapping efficiency due to the confounding effects of distance from the trap from which marked smolt were released and time of day of release. Trapping efficiencies varied significantly between two different release locations for both coho and chinook salmon smolt. Significant differences also resulted at the lower release site when the time of release was varied. We recommend continuing to evaluate the effects of release location and time of day on trapping efficiency at Deep Creek.

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APPENDIX A. DAILY CATCH HISTORIES

Appendix A1.-Daily and cumulative catches of chinook salmon, coho salmon, Dolly Varden, and steelhead smolt using a rotary screw trap in Deep Creek, 1995.

Date	Age-1 Chinook Salmon		Age-0 Chinook Salmon		Coho Salmon		Dolly Varden		Steelhead	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
5/16	12	12			0	0	140	140	0	0
5/17	17	29			3	3	148	288	0	0
5/18	25	54			4	7	175	463	0	0
5/19	21	75			7	14	202	665	3	3
5/20	27	102			5	19	161	826	1	4
5/21 ^a	0	102			0	19	0	826	0	4
5/22	7	109			0	19	147	973	1	5
5/23	36	145			9	28	227	1,200	0	5
5/24	11	156			9	37	265	1,465	0	5
5/25 ^a	1	157			0	37	10	1,475	0	5
5/26 ^a	6	163			3	40	6	1,481	0	5
5/27	15	178			36	76	236	1,717	0	5
5/28	33	211			59	135	254	1,971	0	5
5/29	22	233			56	191	262	2,233	0	5
5/30	26	259			76	267	318	2,551	0	5
5/31	21	280			75	342	243	2,794	0	5
6/01	29	309			109	451	321	3,115	0	5
6/02	27	336			140	591	246	3,361	0	5
6/03	13	349			133	724	107	3,468	0	5
6/04	5	354			102	826	63	3,531	0	5
6/05	24	378			113	939	93	3,624	0	5
6/06	18	396			108	1,047	22	3,646	0	5
6/07	27	423			186	1,233	97	3,743	1	6
6/08	39	462			399	1,632	112	3,855	1	7
6/09	28	490			431	2,063	53	3,908	0	7
6/10	5	495			201	2,264	3	3,911	0	7
6/11	7	502			159	2,423	15	3,926	0	7
6/12	5	507			349	2,772	12	3,938	1	8
6/13	22	529			551	3,323	13	3,951	0	8

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Date	Age-1 Chinook Salmon		Age-0 Chinook Salmon		Coho Salmon		Dolly Varden		Steelhead	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
6/14	53	582			798	4,121	11	3,962	0	8
6/15	99	681			1140	5,261	12	3,974	2	10
6/16	79	760			790	6,051	2	3,976	2	12
6/17	40	800			662	6,713	2	3,978	3	15
6/18	71	871			555	7,268	2	3,980	5	20
6/19	86	957			452	7,720	1	3,981	5	25
6/20	257	1,214			473	8,193	3	3,984	14	39
6/21	279	1,493			315	8,508	1	3,985	10	49
6/22	291	1,784			312	8,820	1	3,986	10	59
6/23	172	1,956			169	8,989	1	3,987	7	66
6/24	371	2,327			168	9,157	2	3,989	1	67
6/25	183	2,510			154	9,311	2	3,991	3	70
6/26	216	2,726			124	9,435	0	3,991	19	89
6/27	270	2,996			107	9,542	2	3,993	34	123
6/28	535	3,531			169	9,711	4	3,997	31	154
6/29	389	3,920			84	9,795	0	3,997	21	175
6/30	404	4,324			50	9,845	0	3,997	21	196
7/01	455	4,779	250	250	74	9,919	0	3,997	14	210
7/02	302	5,081	200	450	57	9,976	0	3,997	16	226
7/03	154	5,235	74	524	69	10,045	0	3,997	34	260
7/04	279	5,514	100	624	67	10,112	0	3,997	9	269
7/05	214	5,728	74	698	34	10,146	0	3,997	22	291
7/06	232	5,960	85	783	16	10,162	3	4,000	48	339
7/07	278	6,238	123	906	17	10,179	0	4,000	33	372
7/08	380	6,618	323	1,229	45	10,224	0	4,000	8	380
7/09	272	6,890	87	1,316	17	10,241	1	4,001	34	414
7/10	269	7,159	97	1,413	18	10,259	1	4,002	21	435
7/11	446	7,605	254	1,667	23	10,282	3	4,005	18	453
7/12	150	7,755	176	1,843	21	10,303	0	4,005	17	470
7/13	204	7,959	245	2,088	15	10,318	1	4,006	15	485

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Date	Age-1 Chinook Salmon		Age-0 Chinook Salmon		Coho Salmon		Dolly Varden		Steelhead	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
7/14	157	8,116	416	2,504	37	10,355	0	4,006	4	489
7/15	191	8,307	198	2,702	17	10,372	1	4,007	7	496
7/16	74	8,381	91	2,793	16	10,388	2	4,009	6	502
7/17	188	8,569	172	2,965	14	10,402	0	4,009	8	510
7/18	199	8,768	207	3,172	23	10,425	3	4,012	13	523
7/19	137	8,905	290	3,462	35	10,460	5	4,017	14	537
7/20	66	8,971	73	3,535	21	10,481	1	4,018	4	541
7/21	92	9,063	150	3,685	19	10,500	1	4,019	2	543
7/22	91	9,154	195	3,880	12	10,512	1	4,020	2	545
7/23	48	9,202	178	4,058	12	10,524	1	4,021	5	550
7/24	76	9,278	506	4,564	17	10,541	3	4,024	5	555
7/25	124	9,402	339	4,903	49	10,590	2	4,026	0	555
7/26	15	9,417	200	5,103	13	10,603	1	4,027	1	556
7/27	10	9,427	391	5,494	19	10,622	1	4,028	1	557
7/28	9	9,436	218	5,712	23	10,645	1	4,029	2	559
7/29	15	9,451	384	6,096	24	10,669	1	4,030	2	561
7/30	12	9,463	192	6,288	21	10,690	1	4,031	0	561
7/31	8	9,471	204	6,492	21	10,711	2	4,033	1	562
8/01	4	9,475	339	6,831	25	10,736	1	4,034	0	562
8/02	4	9,479	354	7,185	6	10,742	0	4,034	0	562
8/03	3	9,482	352	7,537	0	10,742	2	4,036	1	563
8/04	3	9,485	66	7,603	5	10,747	9	4,045	0	563
8/05	1	9,486	72	7,675	6	10,753	4	4,049	0	563
8/06	3	9,489	48	7,723	3	10,756	4	4,053	0	563
8/07	0	9,489	121	7,844	12	10,768	9	4,062	1	564
8/08	0	9,489	185	8,029	0	10,768	0	4,062	7	571
8/09	0	9,489	90	8,119	20	10,788	2	4,064	4	575
8/10	1	9,490	82	8,201	17	10,805	8	4,072	4	579
8/11	0	9,490	21	8,222	6	10,811	1	4,073	0	579
8/12	0	9,490	45	8,267	11	10,822	2	4,075	0	579

^a Debris and high water conditions interfered with trapping on these dates resulting in incomplete catch data.

Appendix A2.-Daily smolt catches using a rotary screw trap in the Kenai River, 1995 .

Date	Site	River Kilometer	Location	Chinook Salmon	Coho Salmon	Sockeye Salmon
6/17	E	20.1	Pillars	4	60	6
6/18	E	20.1	Pillars	7	113	5
6/19	E	20.1	Pillars	10	69	7
6/20	F	20.9	Honeymoon	24	87	8
6/21	F	20.9	Honeymoon	36	146	11
6/22	F	20.9	Honeymoon	16	174	3
6/23	G	72.4	Kenai Keys	4	42	0
6/24	G	72.4	Kenai Keys	4	64	0
6/25	G	72.4	Kenai Keys	14	58	0
6/28	C	1.6	City Dock	18	0	485
6/29	C	1.6	City Dock	53	10	753
6/30	C	1.6	City Dock	49	5	356
7/01	C	1.6	City Dock	69	2	440
7/03	C	1.6	City Dock	62	4	74
7/04	D	3.2	CWF Buoy	90	10	226
7/05	D	3.2	CWF Buoy	25	15	123
7/06	D	3.2	CWF Buoy	16	5	32
7/07	D	3.2	CWF Buoy	20	5	319
7/08	A	0.8	Anchored	31	1	58
7/11	B	1.2	CISPRI Buoy	214	1	309
7/12	B	1.2	CISPRI Buoy	207	0	398
7/13	B	1.2	CISPRI Buoy	165	5	252
7/14	B	1.2	CISPRI Buoy	152	8	191
7/16	B	1.2	CISPRI Buoy	194	0	n/a
7/17	B	1.2	CISPRI Buoy	70	1	38
7/18	B	1.2	CISPRI Buoy	48	0	110
7/19	B	1.2	CISPRI Buoy	4	0	18
7/20	B	1.2	CISPRI Buoy	4	0	3
7/21	B	1.2	CISPRI Buoy	2	0	4
7/25	B	1.2	CISPRI Buoy	11	0	20
7/26	B	1.2	CISPRI Buoy	6	0	5

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Date	Site	River Kilometer	Location	Chinook Salmon	Coho Salmon	Sockeye Salmon
7/27	B	1.2	CISPRI Buoy	40	0	141
7/28	B	1.2	CISPRI Buoy	38	1	177
7/29	B	1.2	CISPRI Buoy	56	0	176
7/30	B	1.2	CISPRI Buoy	78	0	89
7/31	B	1.2	CISPRI Buoy	133	1	186
8/10	B	1.2	CISPRI Buoy	366	2	23
8/11	B	1.2	CISPRI Buoy	258	0	7
8/12	B	1.2	CISPRI Buoy	335	0	18
8/13	B	1.2	CISPRI Buoy	182	2	19
8/14	B	1.2	CISPRI Buoy	112	1	3
8/15	B	1.2	CISPRI Buoy	145	3	10
8/16	B	1.2	CISPRI Buoy	73	0	5
8/17	B	1.2	CISPRI Buoy	32	1	8
8/26	B	1.2	CISPRI Buoy	303	7	12
8/27	B	1.2	CISPRI Buoy	122	3	4
8/28	B	1.2	CISPRI Buoy	113	3	5
8/29	B	1.2	CISPRI Buoy	117	4	5
8/30	B	1.2	CISPRI Buoy	121	9	8
8/31	B	1.2	CISPRI Buoy	98	2	5
9/01	B	1.2	CISPRI Buoy	36	8	6
9/07	B	1.2	CISPRI Buoy	15	9	6
9/08	B	1.2	CISPRI Buoy	14	12	6
9/09	B	1.2	CISPRI Buoy	16	7	7
9/10	B	1.2	CISPRI Buoy	9	10	7
9/11	B	1.2	CISPRI Buoy	3	4	2
9/12	C	1.6	City Dock	1	3	3
9/13	C	1.6	City Dock	1	18	2
9/14	C	1.6	City Dock	1	3	4
9/15	C	1.6	City Dock	0	0	0
9/21	C	1.6	City Dock	0	1	0

APPENDIX B. HISTORICAL TAGGING SUMMARY

Appendix B1.-Dates, codes, and numbers of wild chinook and coho salmon tagged and released in Deep Creek and the Kenai River during 1993 through 1995.

Year	Species	Location	RM	Dates	Code	Brood		
						Year	Age	Number
1993	Chinook	Kenai R.	44	7/28 - 8/04	31-22-23	1992	0	4,373
1993	Chinook	Kenai R.	44	8/05 - 8/12	31-22-60	1992	0	11,411
1993	Chinook	Kenai R.	44	8/16 - 8/24	31-22-61	1992	0	12,830
1993	Chinook	Kenai R.	44	8/25 - 8/31	31-22-62	1992	0	10,521
1993	Chinook	Kenai R.	44	9/01 - 9/13	31-22-63	1992	0	13,567
1993	Chinook	Kenai R.	15	7/21 - 7/28	31-22-30	1992	0	5,845
1993	Chinook	Kenai R.	15	7/28 - 8/03	31-22-31	1992	0	5,788
1993	Chinook	Kenai R.	15	8/03 - 8/09	31-22-44	1992	0	12,087
1993	Chinook	Kenai R.	15	8/09 - 8/17	31-22-45	1992	0	11,888
1993	Chinook	Kenai R.	15	8/17 - 8/24	31-22-46	1992	0	11,639
1993	Chinook	Kenai R.	15	8/24 - 8/30	31-22-47	1992	0	11,721
1993	Chinook	Kenai R.	15	8/31 - 9/07	31-22-56	1992	0	11,843
1993	Chinook	Kenai R.	15	9/07 - 9/10	31-22-57	1992	0	11,611
1993	Chinook	Kenai R.	15	9/10 - 9/14	31-22-58	1992	0	12,048
1993	Chinook	Kenai R.	15	9/14 - 9/15	31-22-59	1992	0	5,225
1994	Chinook	Kenai R.	15	7/18 - 7/27	31-22-18	1993	0	5,885
1994	Chinook	Kenai R.	15	7/27 - 8/01	31-22-36	1993	0	5,980
1994	Chinook	Kenai R.	15	8/01 - 8/04	31-22-38	1993	0	6,158
1994	Chinook	Kenai R.	15	8/04 - 8/08	31-22-39	1993	0	6,222
1994	Chinook	Kenai R.	15	8/08 - 8/09	31-22-37	1993	0	6,258
1994	Chinook	Kenai R.	15	8/09 - 8/12	31-22-50	1993	0	11,581
1994	Chinook	Kenai R.	15	8/12 - 8/18	31-22-49	1993	0	11,512
1994	Chinook	Kenai R.	15	8/18 - 8/24	31-22-48	1993	0	11,695
1994	Chinook	Kenai R.	15	8/24 - 9/02	31-22-51	1993	0	11,373
1994	Chinook	Kenai R.	15	9/02 - 9/14	31-24-09	1993	0	11,445
1995	Chinook	Kenai R.	2	6/22 - 7/19	13-01-03-08-03	1993	1	1,479
1995	Chinook	Kenai R.	15	7/25 - 8/03	13-01-03-08-04	1994	0	14,030
1995	Chinook	Kenai R.	15	8/03 - 8/14	13-01-03-08-05	1994	0	13,724
1995	Chinook	Kenai R.	15	8/14 - 8/22	13-01-03-08-06	1994	0	13,745
1995	Chinook	Kenai R.	15	8/22 - 8/30	13-01-03-08-07	1994	0	13,752
1995	Chinook	Kenai R.	15	8/30 - 8/31	13-01-03-08-08	1994	0	2,011

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Year	Species	Location	RM	Dates	Code	Brood		
						Year	Age	No.
1994	Chinook	Deep Cr	0.5	5/20 - 6/28	31-22-16	1992	1	2,430
1994	Chinook	Deep Cr	0.5	6/28 - 7/04	31-23-60	1992	1	2,684
1994	Chinook	Deep Cr	0.5	7/04 - 7/10	31-23-61	1992	1	2,678
1994	Chinook	Deep Cr	0.5	7/10 - 8/03	31-23-62	1992	1	1,819
1994	Chinook	Deep Cr	0.5	7/21 - 7/29	31-23-63	1993	0	2,837
1994	Chinook	Deep Cr	0.5	7/29 - 8/03	31-24-01	1993	0	807
1995	Chinook	Deep Cr	0.5	5/17 - 6/25	31-24-02	1993	1	2,183
1995	Chinook	Deep Cr	0.5	6/25 - 7/21	31-22-35	1993	1	5,719
1995	Chinook	Deep Cr	0.5	7/21 - 8/02	13-01-03-08-15	1993	1	492
1995	Chinook	Deep Cr	0.5	7/14 - 8/12	13-01-03-08-09	1994	0	5,174
1995	Coho	Deep Cr	0.5	5/18 - 6/17	31-22-33	1992	2	5,760
1995	Coho	Deep Cr	0.5	6/17 - 7/20	31-22-34	1992	2	3,911

